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Ha et al.

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(54) **STRUCTURE FOR SHIELDING ELECTROMAGNETIC WAVES, DOOR AND COOKING APPLIANCE THEREWITH**

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(30) **Foreign Application Priority Data**

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H05B 6/76 (2006.01)

(52) **U.S. Cl.**
CPC ***H05B 6/763*** (2013.01); ***H05B 6/766*** (2013.01)

(58) **Field of Classification Search**
CPC H05B 6/763; H05B 6/766; H05B 6/6414
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,705,797	A *	1/1998	Seo	H05B 6/763 219/742
2003/0141298	A1 *	7/2003	Lee	H05B 6/763 219/741
2005/0072777	A1 *	4/2005	Kim	H05B 6/763 219/741

FOREIGN PATENT DOCUMENTS

KR	1020020022954	A	3/2002
KR	1020030012638	A	2/2003
KR	1020050005020	A	1/2005

* cited by examiner

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(57) **ABSTRACT**

Disclosed herein are a structure for shielding electromagnetic waves, a door and a cooking appliance having the same. The structure for shielding electromagnetic waves includes a choke seal structure having a bottom face extended from a side wall portion formed at a periphery of a door in a plane direction defined by the door, an inner side face extended from the bottom face in a thickness direction of the door, and a top face extended from the inner side face toward side wall portion, the choke seal structure having a length extending along the periphery of the door, a plurality of slots arranged in a longitudinal direction of the choke seal structure at a predetermined spacing and partitioning the choke seal structure into a plurality of chokes, and a connecting face connecting between the top faces of some of the plurality of chokes, each of which has a latch hole formed in its inner side face.

16 Claims, 6 Drawing Sheets

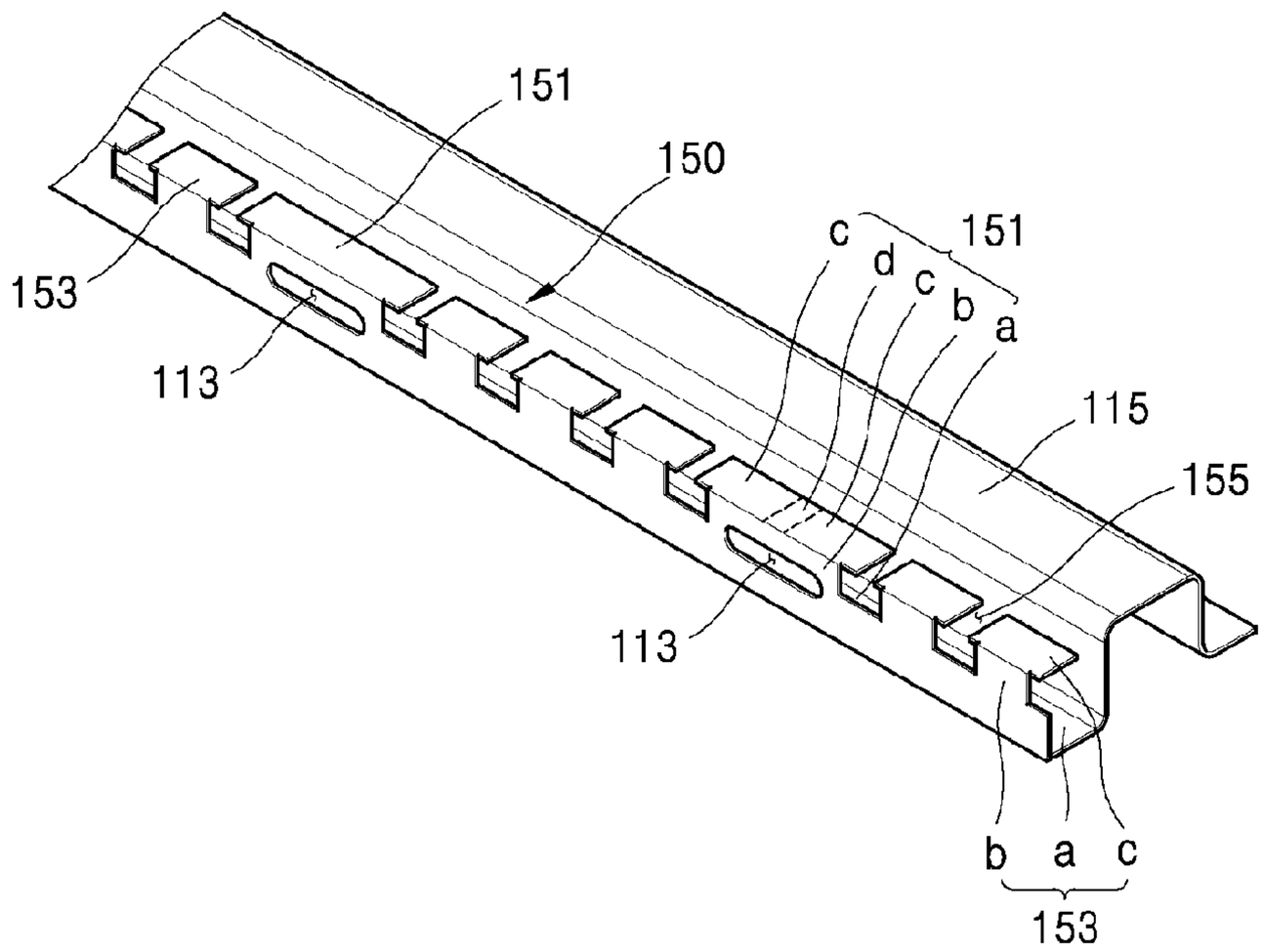


FIG. 1

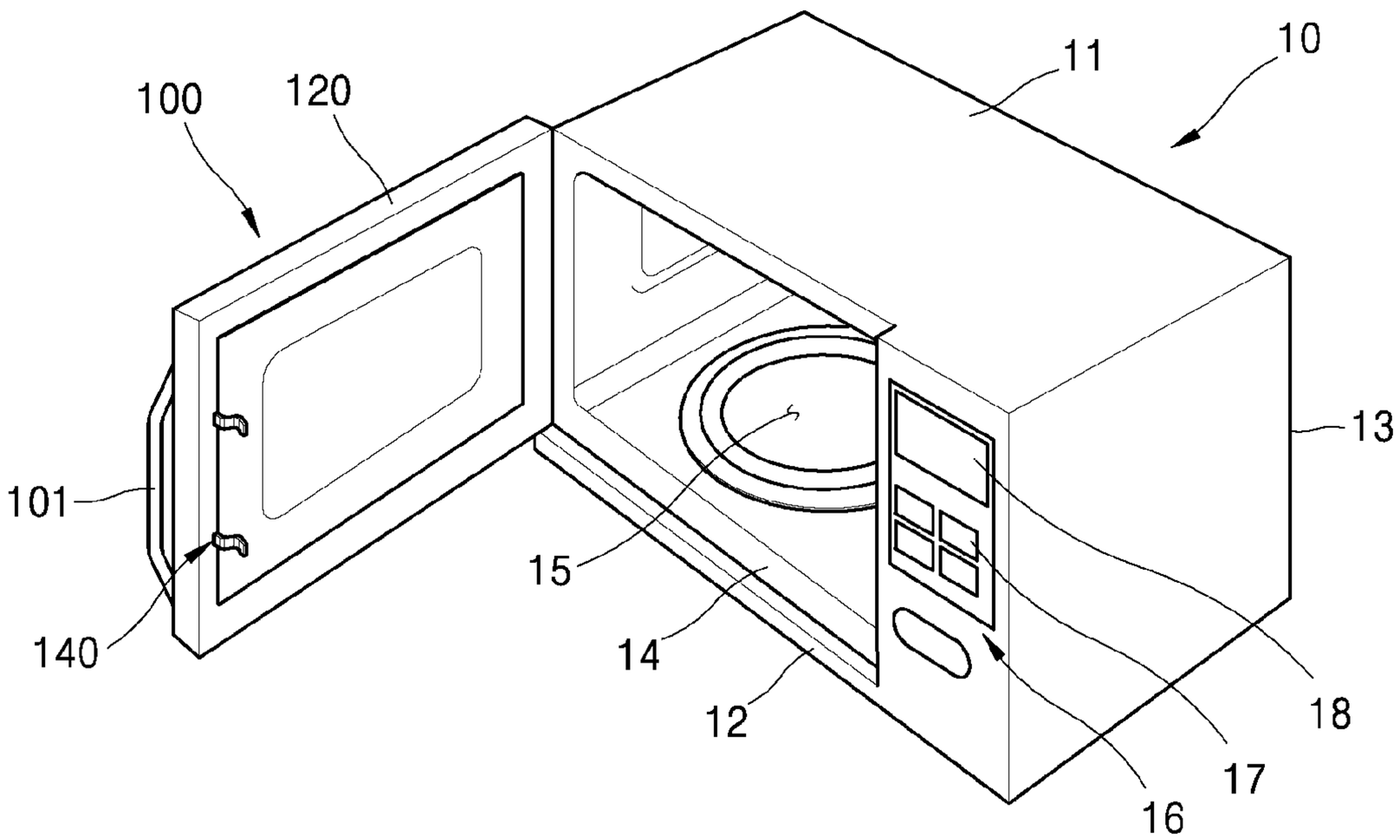


FIG. 2

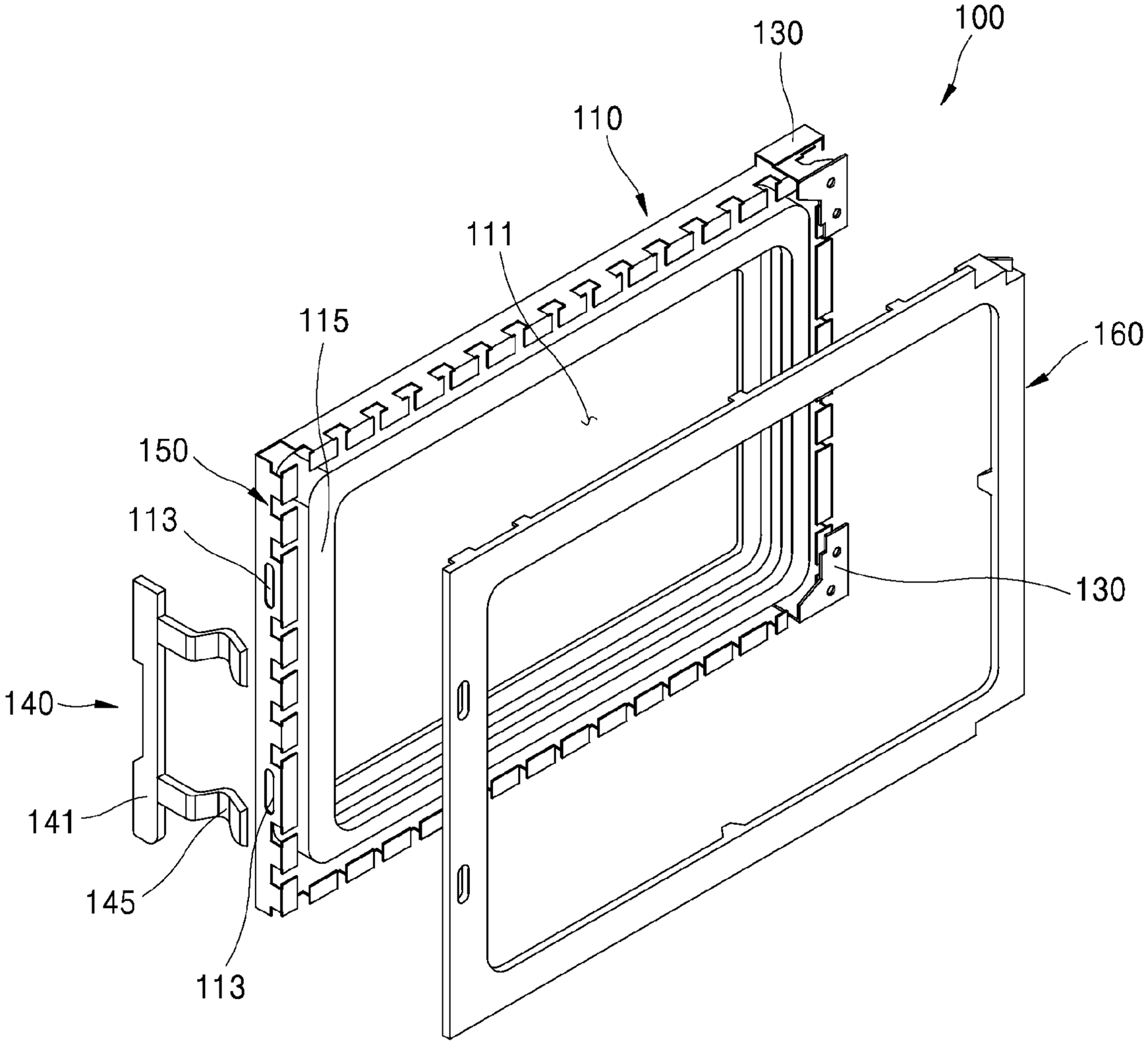


FIG. 3

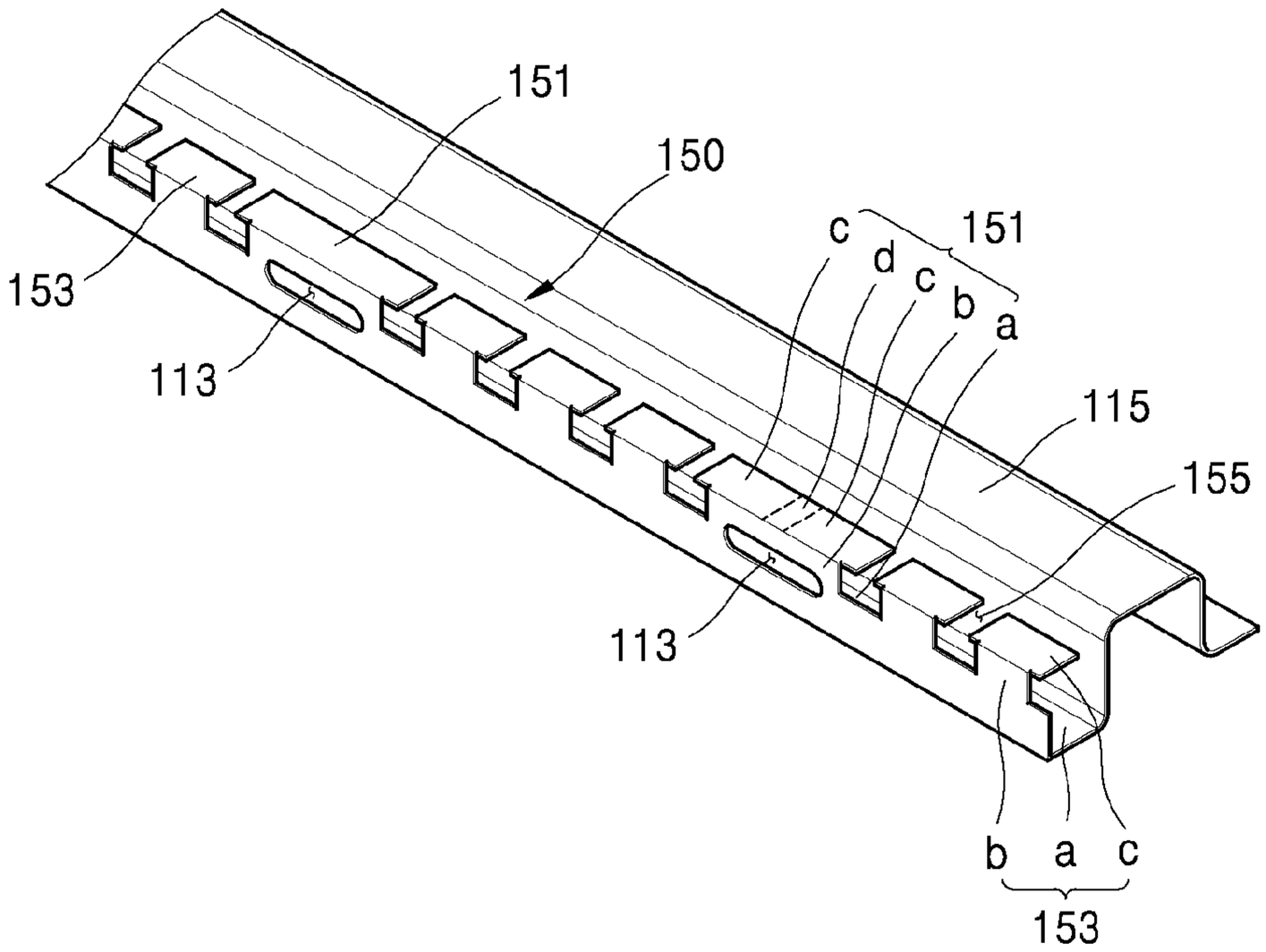


FIG. 4

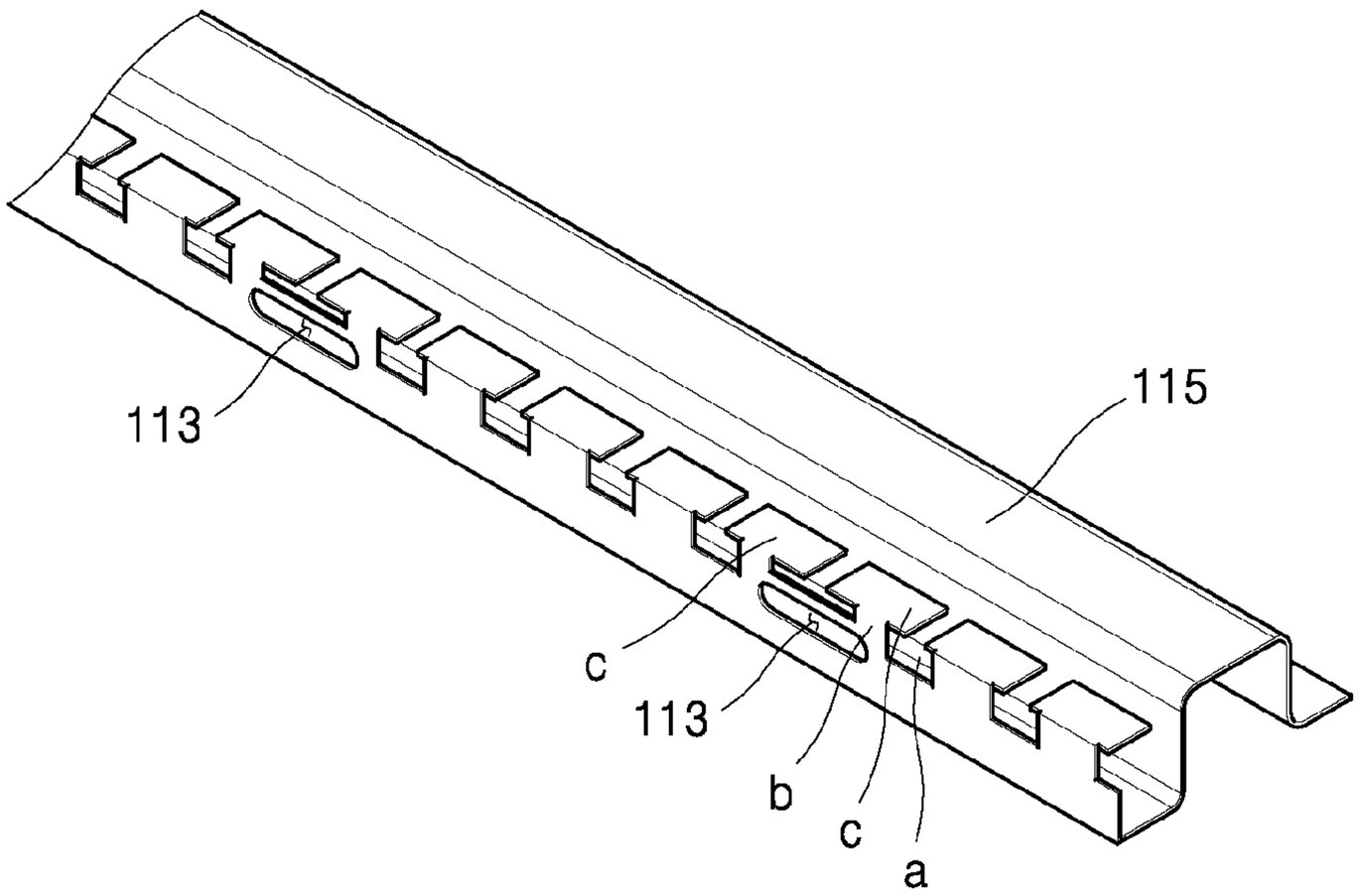


FIG. 5

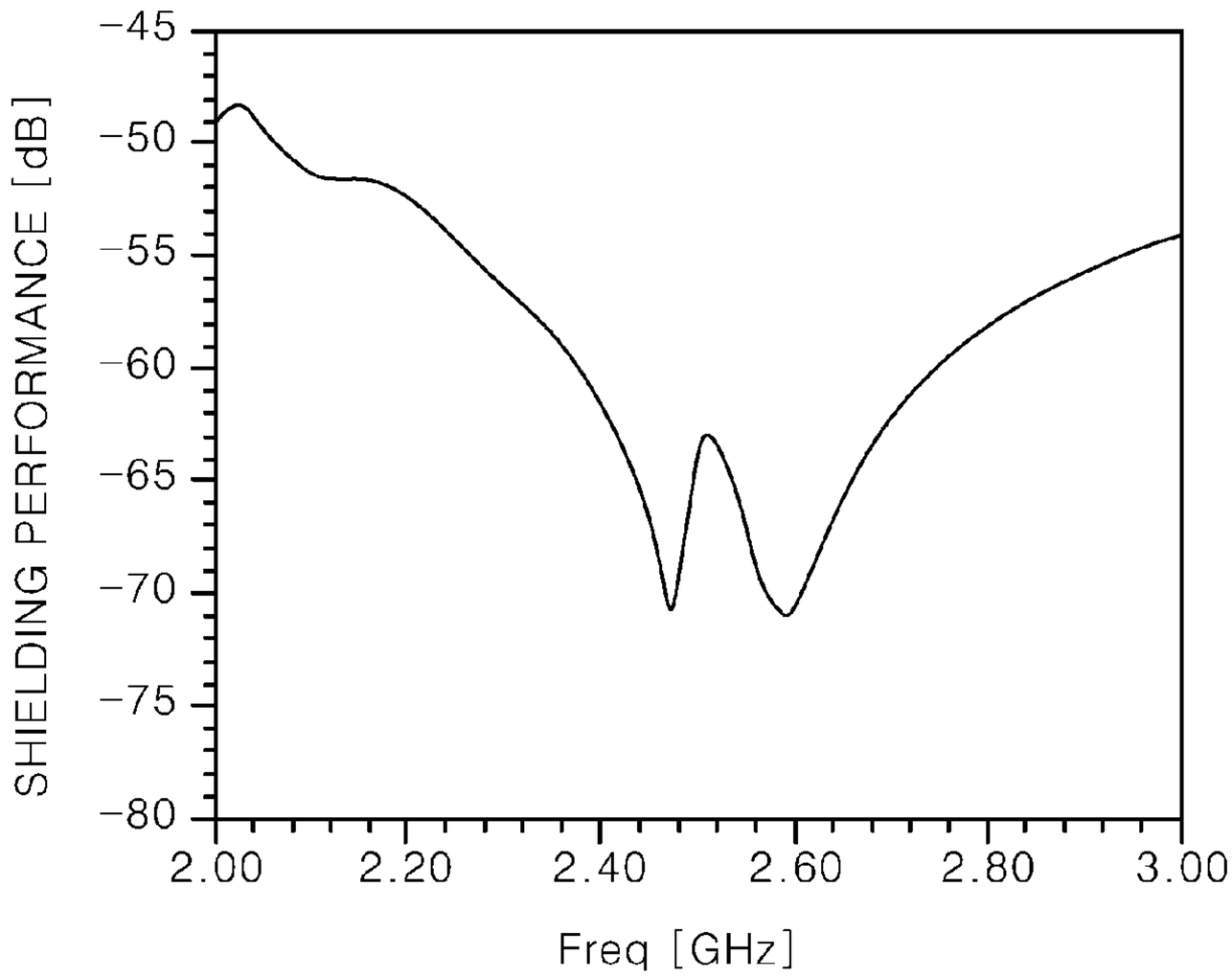

SHIELDING PERFORMANCE [dB]
-45
-50
-55
-60
-65
-70
-75
-80
2.00
2.20
2.40
2.60
2.80
3.00
Freq [GHz]

FIG. 6

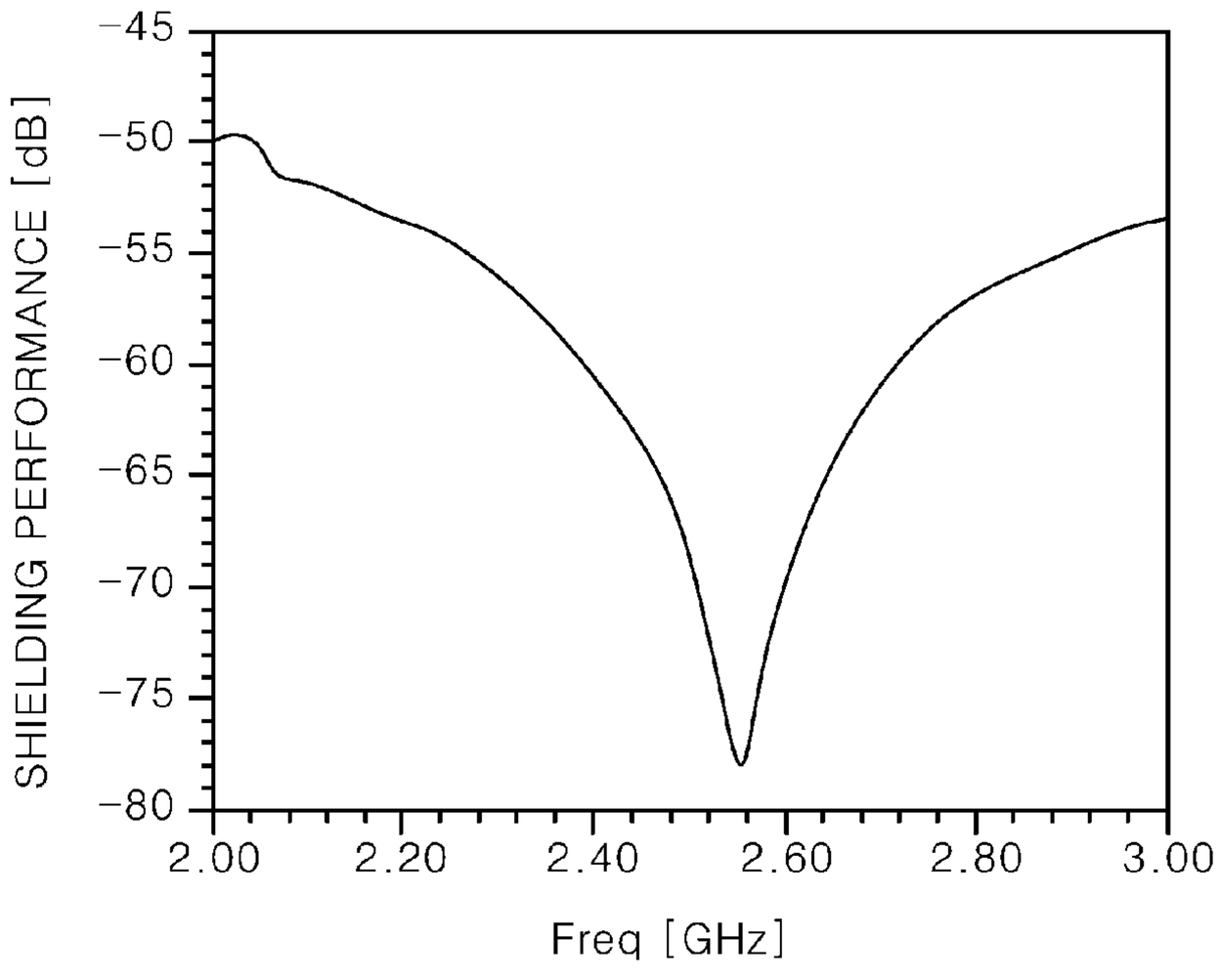

SHIELDING PERFORMANCE [dB]
-45
-50
-55
-60
-65
-70
-75
-80
2.00
2.20
2.40
2.60
2.80
3.00
Freq [GHz]

FIG. 7

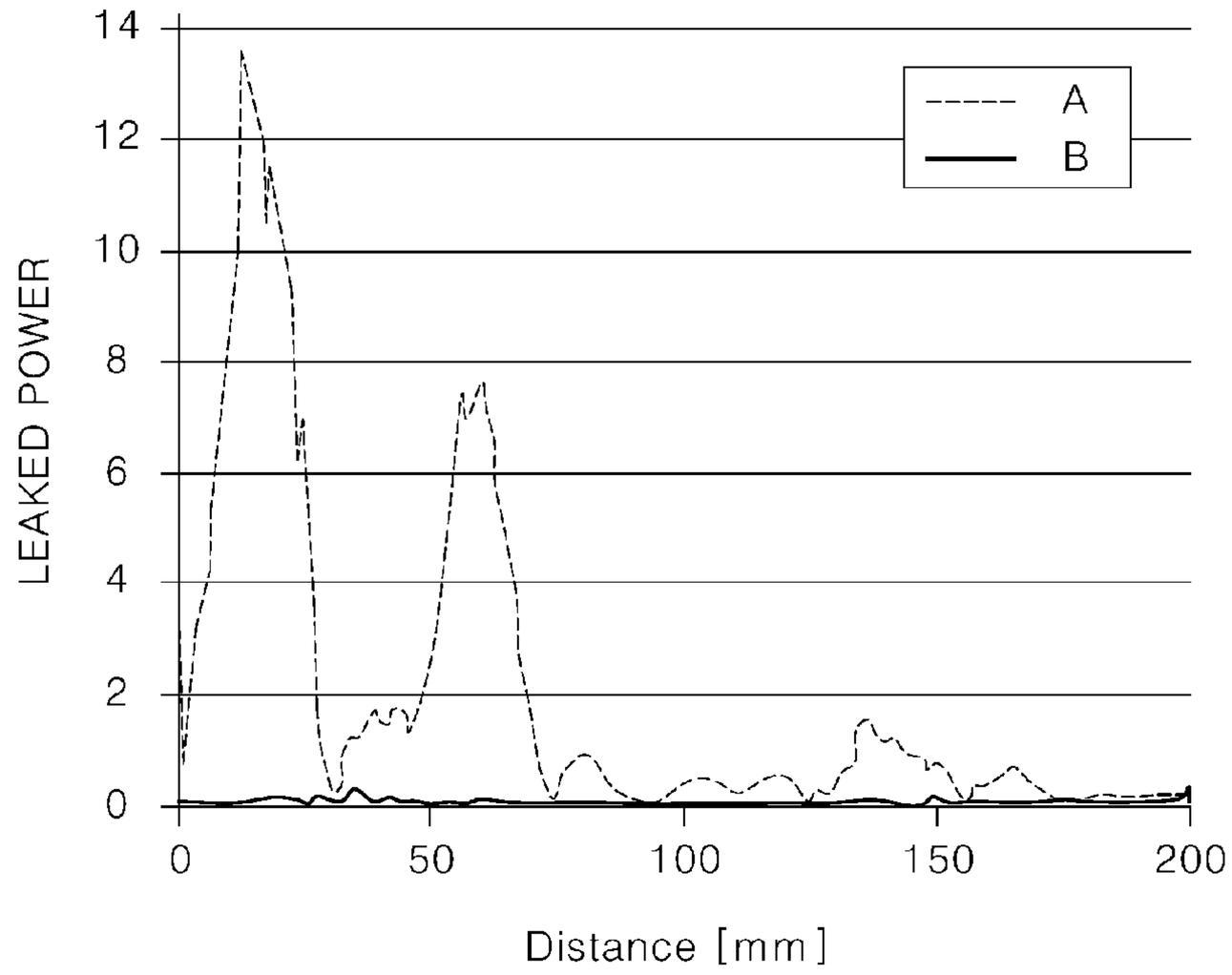

14
12
10
8
6
4
2
0
LEAKED POWER
0
50
100
150
200
Distance [mm]
A
B

FIG. 8

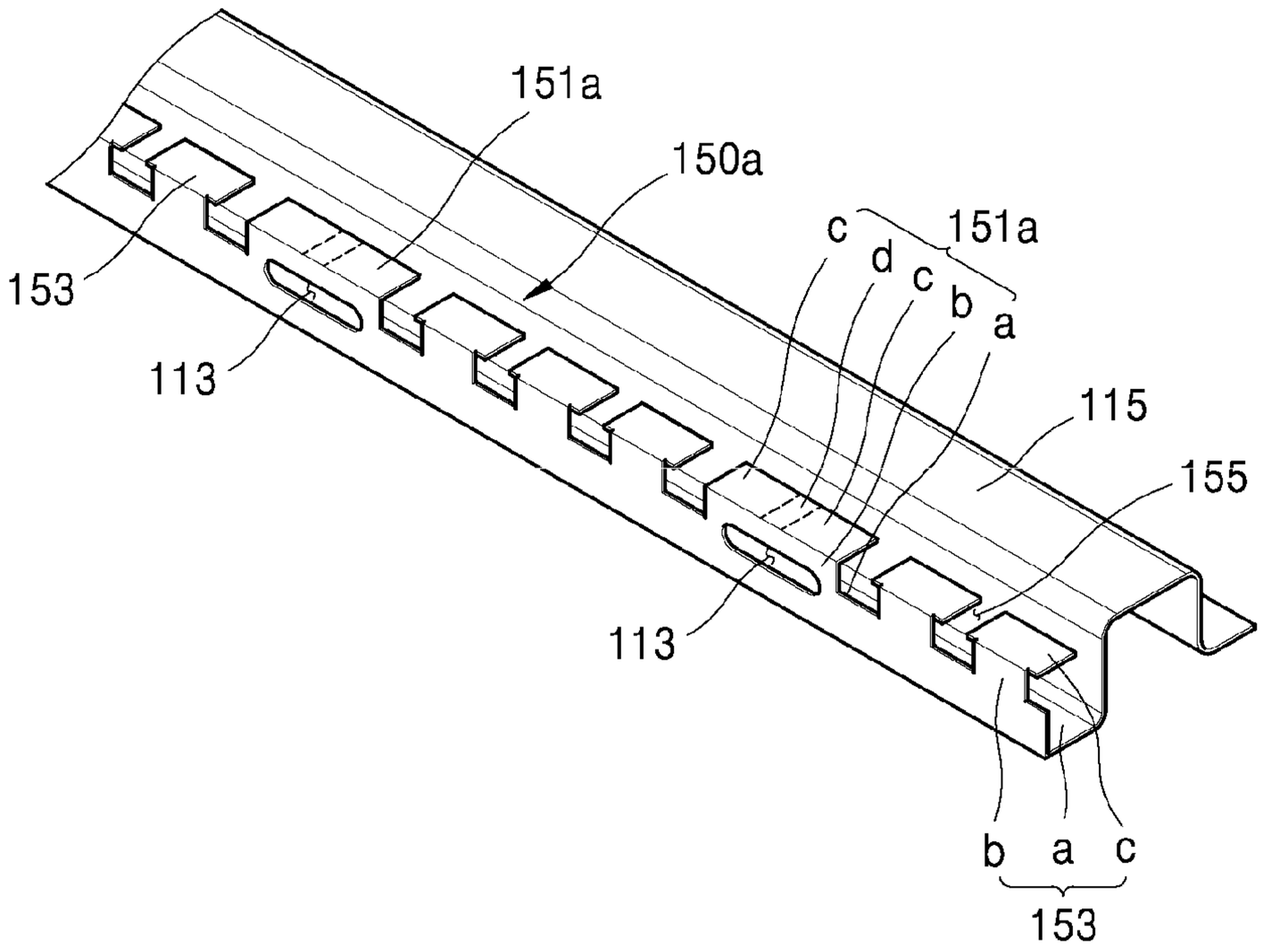
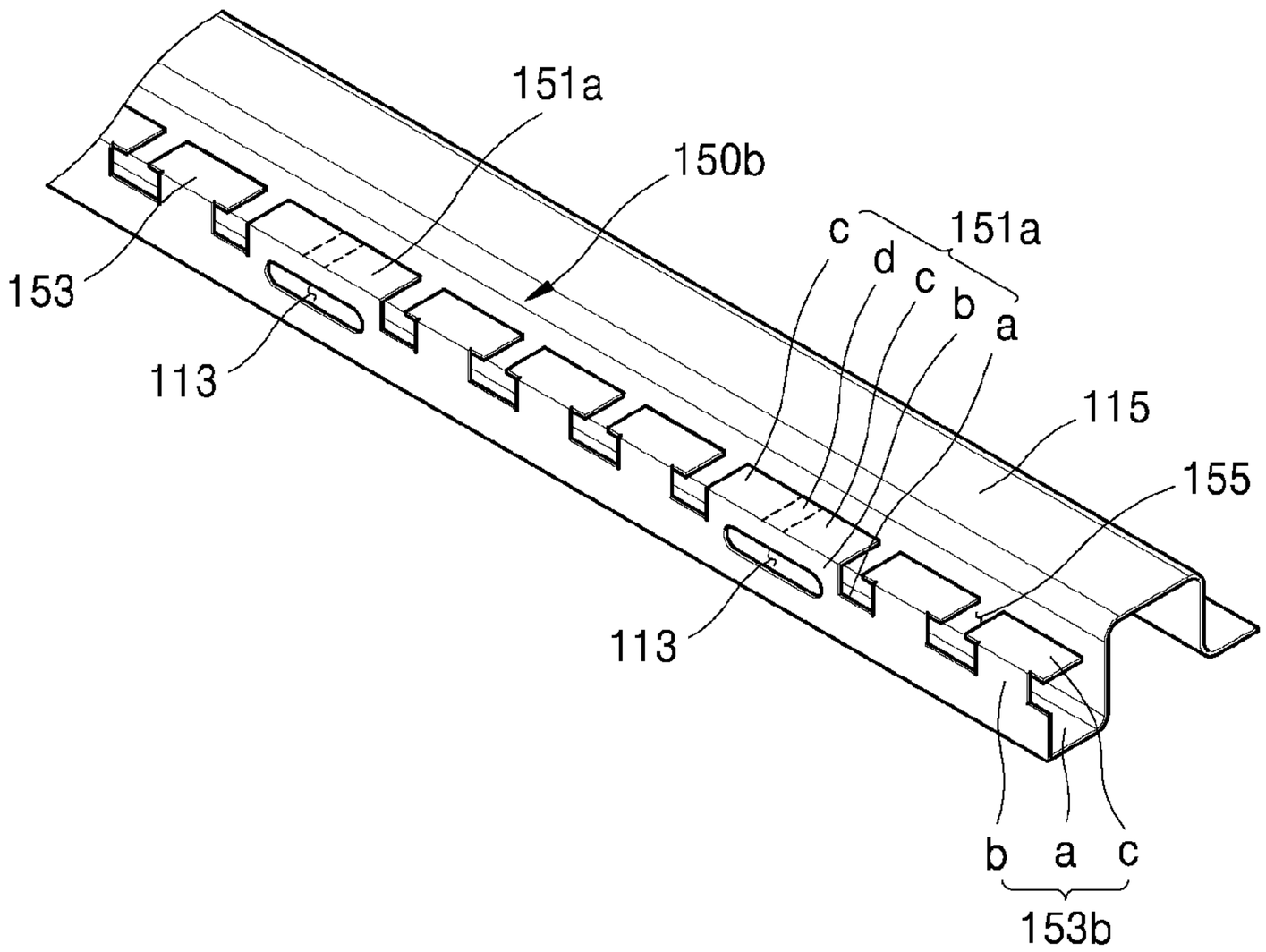

151a
150a
153
113
c
d
c
b
a
151a
115
155
113
b
a
c
153

FIG. 9



STRUCTURE FOR SHIELDING ELECTROMAGNETIC WAVES, DOOR AND COOKING APPLIANCE THEREWITH

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the priority of Korean Patent Application No. 10-2017-0088620 filed on Jul. 12, 2017, in the Korean Intellectual Property Office, the disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND

1. Technical Field

The present disclosure relates to a structure for shielding electromagnetic waves, a door and a cooking appliance therewith. More specifically, the present disclosure relates to a structure for shielding electromagnetic waves to block leakage of electromagnetic waves, a door and a cooking appliance therewith.

2. Description of the Related Art

A cooking appliance is a kind of household appliances for cooking food, which is installed in a kitchen and is used to cook food people want. Such cooking appliances may be classified by the heat source, shape or the type of fuel.

Cooking appliances may be classified into open-type cooking appliances and closed-type cooking appliances depending on where food is placed and how to cook it. The closed-type cooking appliances include an oven, a microwave oven and the like, while open-type cooking appliances include a cooktop, a hob and the like.

A closed-type cooking appliance has a closed space where food is placed, and the food is cooked by heating the closed space. A closed-type cooking appliance includes therein a chamber in which food is placed and which is closed during cooking. In the chamber, food is actually cooked. A heat source is disposed inside or outside the chamber to heat it.

Among closed-type cooking appliances, a microwave oven heats food by generating microwaves by using electricity to pass them into food accommodated in a cooking chamber, and inducing molecular motion therein.

The microwave oven is a kitchen appliance that irradiates high frequency waves of a magnetron onto food to be cooked to heat the inside and the outside of the food simultaneously. It has the advantages that the heat efficiency is high and thus the cooking time is drastically shortened, that the loss of nutrition is reduced in the process of cooking, defrosting and warming of food, and that food can be cooked as it is in the container. Therefore, microwave ovens are widely used because of these advantages.

Typically, such a microwave oven includes a door for opening and closing a cooking chamber formed inside the main body. Types of the doors for microwave ovens may include a hinged door, an upper-and-over door and a sliding door according to the mechanisms. Among these, the hinged door is most commonly used.

Between the main body and the door, a latch is disposed for fixing the door for opening or closing the cooking chamber.

The latch serves as a hook to keep the door closed, and also senses whether the door is closed and prohibits cooking if the door is open.

A door seal is formed along the periphery of the rear face of the door facing the cooking chamber, which comes in tight contact with the front face of the main body. A choke is disposed on the outer periphery of the door seal, which is a structure for shielding electromagnetic waves for preventing the electromagnetic waves in the cooking chamber from leaking through the gap between the cooking chamber and the door.

The choke includes a plurality of choke slits arranged along the periphery of the door. Each of the choke slits has a connecting portion extending from the periphery the door toward the cooking chamber, and a bending portion bent at the end of the connecting portion and extending toward the door seal.

The choke thus formed forms a circuit for shielding electromagnetic waves LC together with the front face of the main body facing the door. In order to form the circuit of excellent performance, it is typically desired to design the choke so that the choke slits have a periodic structure.

Incidentally, in order to install the latch in the door, a mounting hole has be formed so that a part of the latch installed in the door, i.e., a holding part to be engaged with the front face of the main body passes through.

Since both the latch and the choke have to be disposed in the area facing the front face of the main body, the mounting hole may be formed in the region where the choke is formed or in the region very close to the choke.

When this happens, as the size of the mounting hole increases, it is more likely that the electromagnetic waves leak through the mounting hole, and the shape of the choke slits may become uniform at the position where the mounting hole is formed. As a result, the periodic structure of the choke is broken, and thus the performance for shielding electromagnetic waves of the choke may be deteriorated.

In order to overcome this issue, it may be contemplated to reduce the size of the mounting hole. Unfortunately, it is difficult and takes more time to reduce the size the mounting hole, such that the productivity of the cooking appliance is lowered.

SUMMARY

It is an object of the present disclosure to provide an improved structure for shielding electromagnetic waves capable of providing a stable performance even with a hole for mounting a latch, a door and a cooking appliance having the structure.

It is another object of the present disclosure to provide a stable electromagnetic wave shielding performance without increasing difficulty and time required for mounting a latch.

In accordance with one aspect of the present disclosure, a structure for shielding electromagnetic waves includes: a choke seal structure having a bottom face extended from a side wall portion formed at a periphery of a door in a plane direction defined by the door, an inner side face extended from the bottom face in a thickness direction of the door, and a top face extended from the inner side face toward side wall portion, the choke seal structure having a length extending along the periphery of the door; a plurality of slots arranged in a longitudinal direction of the choke seal structure at a predetermined spacing and partitioning the choke seal structure into a plurality of chokes; and a connecting face connecting between the top faces of some of the plurality of chokes, each of which has a latch hole formed in its inner side face.

The connecting face may be flush with the top faces and connect therebetween.

The top face may protrude more than the inner side face in the longitudinal direction of the choke seal structure.

The length of the top faces connected by the connecting face may be equal to the length of the inner side face in the longitudinal direction of the choke seal structure.

In accordance with another aspect of the present disclosure, a structure for shielding electromagnetic waves comprises: a choke seal structure having a bottom face extended from a side wall portion formed at a periphery of a door in a plane direction defined by the door, an inner side face extended from the bottom face in a thickness direction of the door, and a top face extended from the inner side face toward side wall portion, the choke seal structure having a length extending along the periphery of the door; and a plurality of slots arranged in a longitudinal direction of the choke seal structure at a predetermined spacing and partitioning the choke seal structure into a plurality of chokes, wherein the chokes are divided into a first choke having a latch hole formed in the inner side face and a second choke having no latch hole formed therein, and wherein a length of the top face of the first choke is larger than a length of the top face of the second choke.

The top face may protrude more than the inner side face in the longitudinal direction of the choke seal structure.

The length of the top face of the first choke may be equal to the length of the inner side face in the longitudinal direction of the choke seal structure.

In accordance with another aspect of the present disclosure, a door includes: a door panel forming a frame of the door; and a structure disposed at the door panel and for shielding electromagnetic waves, wherein the structure for shielding electromagnetic waves comprises: a choke seal structure having a bottom face extended from a side wall portion formed at a periphery of a door in a plane direction defined by the door, an inner side face extended from the bottom face in a thickness direction of the door, and a top face extended from the inner side face toward side wall portion, the choke seal structure having a length extending along the periphery of the door; a plurality of slots arranged in a longitudinal direction of the choke seal structure at a predetermined spacing and partitioning the choke seal structure into a plurality of chokes; and a connecting face connecting between the top faces of some of the plurality of chokes, each of which has a latch hole formed in its inner side face.

In accordance with another aspect of the present disclosure, a cooking appliance includes: a main body having a cooking chamber therein and an open front face; a door connected to the front face of the main body to open or close the cooking chamber; and a latch mechanism installed at the door to fasten or release the door to/from the main body, wherein the door comprises a door panel forming a frame of the door; and a latch hole formed by penetrating a structure for shielding electromagnetic waves and passes therethrough at least a part of the latch mechanism installed in the door, wherein the structure for shielding electromagnetic waves comprises: a choke seal structure having a bottom face extended from a side wall portion formed at a periphery of a door in a plane direction defined by the door, an inner side face extended from the bottom face in a thickness direction of the door, and a top face extended from the inner side face toward side wall portion, the choke seal structure having a length extending along the periphery of the door; a plurality of slots arranged in a longitudinal direction of the choke seal structure at a predetermined spacing and partitioning the choke seal structure into a plurality of chokes; and a connecting face connecting between the top faces of some of the plurality of chokes, each of which has a latch hole formed in its inner side face.

The inner side surface may form an inductance component, the top face may form a capacitance component, and the connecting face may increase the capacitance component formed by the top face.

According to the structure for shielding electromagnetic waves according to the exemplary embodiment of the present disclosure, a door and a cooking appliance therewith, the top faces of the chokes having the latch hole formed are connected by the connecting face to thereby increase the overall length of the top face, such that the capacitance C components are increased as much as the inductance L components are decreased, thereby maintaining the resonance frequency f0. Therefore, it is possible to provide stable electromagnetic wave shielding performance even if the latch hole is formed in the choke seal structure.

According to the structure for shielding electromagnetic waves according to the exemplary embodiment of the present disclosure, a door and cooking appliance therewith, a large latch hole is allowed to be formed, so that the inductance L component of the choke can be reduced, and the overall length of the top face can be increased accordingly. Therefore, it is possible to provide a stable electromagnetic wave shielding performance while increasing the size of the latch hole to thereby reducing the degree of difficulty of the latch installation work and reducing the time required.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view of a cooking appliance according to a first exemplary embodiment of the present disclosure;

FIG. **2** is an exploded perspective view of the door shown in FIG. **1**;

FIG. **3** is a perspective view showing the configuration of the choke seal structure shown in FIG. **2**;

FIG. **4** is a perspective view showing a configuration of a choke part formed in a door of an existing cooking appliance;

FIG. **5** is a graph showing an S-parameter measured at a door gap of an existing cooking appliance;

FIG. **6** is a graph showing an S-parameter measured at a door gap of the cooking appliance according to a first exemplary embodiment of the present disclosure;

FIG. **7** is a graph showing results obtained by comparing leaked power measured at a door gap of the existing cooking appliance with that of the cooking appliance according to the first exemplary embodiment of the present disclosure;

FIG. **8** is a perspective view showing the configuration of a choke seal structure according to a second exemplary embodiment of the present disclosure; and

FIG. **9** is a perspective view showing the configuration of a choke seal structure according to a third exemplary embodiment of the present disclosure.

DETAILED DESCRIPTION

Hereinafter, embodiments of a structure for shielding electromagnetic waves according to an exemplary embodiment of the present disclosure, a door including it, and a cooking appliance therewith will be described with reference to the accompanying drawings. In the drawings, the thickness of lines or the size of the elements may be exaggerated and not drawn on scale for the purposes of clarity and convenience. In the following description, the terms or words used in the specification and claims shall not

be construed merely in a conventional and dictionary definition but shall be construed in a meaning and concept corresponding to the technical idea of the present disclosure based on the principle that an inventor is allowed to properly define the concepts of terms in order to describe his or her invention in the best way. Therefore, the definition of such terminologies should be construed based on the contents throughout the specification.

[Overall Structure of Cooking Appliance]

FIG. **1** is a perspective view of a cooking appliance according to a first exemplary embodiment of the present disclosure.

Referring to FIG. **1**, an exterior of the cooking appliance according to an exemplary embodiment of the present disclosure is formed by a main body **10**. The main body **10** may have a generally box shape and is formed of a material having a predetermined strength to protect a plurality of parts disposed therein.

The main body **10** may include a frame **11** forming left and right side faces and an upper face of the main body **10**, a base **12** disposed at the lower portion of the frame **11** to form the bottom of the main body **10**, a rear plate **13** disposed at the rear of the frame **11** to form the rear face of the main body **10**, and a front plate **14** disposed at the front of the frame **11** to form the front face of the main body **10**. In the front plate **14**, an open area for opening a cooking chamber **15** forward is formed.

In the main body **10**, a cooking chamber **15** is formed. The cooking chamber **15** is in a box shape its front face opened. By heating the inner space of the cooking chamber **15** while the cooking chamber **15** is shielded, food is cooked. That is, in the cooking appliance, food is actually cooked inside the cooking chamber **15**.

At the front of the main body **10**, the door **100** for opening or closing the cooking chamber **15** is pivotably provided. The door **100** can open or close the cooking chamber **15** as a side-swinging door that pivots in the lateral direction on one side thereof.

The door **100** has a generally box shape having a predetermined thickness. On the front face of the door **100**, a handle **101** is attached in order for a user to grasp it to pivot the door **100**. The user can easily pivot the door **100** by the handle **101**.

In addition, a control panel **16** is provided on the front face of the main body **10**. The control panel **16** may have a box shape having a predetermined internal space. An input unit **17** is provided on the front face of the control panel **16** to input user's operation signals for operating a cooking appliance.

The input unit **17** is provided with a plurality of operation switches. A user can directly input operation signals by using the switches.

The control panel **16** may further include a display unit **18** for providing operation information of the door and the cooking appliance having the door and cooking information of food. The user can see various information on the cooking appliance via the display unit **18**.

In addition, a heat source for heating the cooking chamber **15** is provided in the main body **10**. More than one heat sources may be implemented.

In this exemplary embodiment, the heat source includes a magnetron capable of supplying a high-frequency waves into the cooking chamber **15**. The magnetron may be installed inside the main body **10**, and may be installed above the cooking chamber **15**.

In addition, an electric field chamber may be formed in the main body **10** above or on a side of the cooking chamber **15**. Electrical components such as a magnetron and a high-voltage transformer are installed inside the electric field chamber.

In addition, the cooking appliance may further include a latch mechanism **140**. In this exemplary embodiment, the latch mechanism **140** is installed at the door **100**. The latch mechanism **140** installed at the door **100** may pass through a latch slot formed in the front face of the main body **10** to be inserted into the main body **10** when the door **100** shields the cooking chamber **15**. In this manner, the latch mechanism **140** inserted into the main body **10** can fix the door **100** to the main body **10** by engaging with a latch lever disposed in the main body **10**.

The pivot movement of the door **100** relative to the main body **10** is inhibited by the latch mechanism **140**, so that the cooking chamber **15** can be substantially shielded by the door **100**. It is possible to sense whether the door **100** is closed or not by detecting whether the latch mechanism **140** is engaged with the latch lever. By doing so, the cooking appliance can be controlled so that it does not cook food while the door **100** is open.

[Structure of Door]

FIG. **2** is an exploded perspective view of the door shown in FIG. **1**.

Referring to FIGS. **1** and **2**, the door **100** includes a door panel **110**, a choke cover **160**, and a structure for shielding electromagnetic waves.

The door panel **110** forms the frame of the door **100** and may be formed in a box shape conforming to the shape of the front face of the main body **10**. On the inner side of the door panel **110**, an opening window **111** may be formed through it to allow the inside of the cooking chamber **15** to be seen from the outside. In this embodiment, the door panel **110** is illustrated as being formed of a metal material having a predetermined strength.

On the outer side of the door panel **110**, a door frame **120** may be installed. The door frame **120** forms the front and side faces of the door **100** and may have a box shape with an opened rear face. The door panel **110** may be accommodated in the door frame **120**. The choke cover **160** to be described later is installed on the rear side of the door panel **110** accommodated in the door frame **120**, thereby forming the rear face of the door **100**.

A hinge member **130** for pivotally connecting the door panel **110** to the main body **10** is installed at one side of the door panel **110** in the lateral direction. The hinge member **130** is installed at each of the upper and lower ends of the side of the door panel **110**. The door panel **110** may open or close the cooking chamber **15** as a side-swing door that pivots in the lateral direction on the side thereof coupled with the main body **10** by the hinge member **130**.

An mounting space for mounting the latch mechanism **140** is formed in the door panel **110**. Such mounting space may be formed at the end on the other side of the door panel **110**, and may be formed in a concave groove shape recessed toward the inside of the door panel **110** from the front side of the door panel **110**.

The latch mechanism **140** may be divided into a coupling portion **141** installed inside the door panel **110** and a hook portion **145** projecting from the door panel **110**.

The coupling portion **141** is inserted into the mounting space formed as described above and in turn installed inside the door panel **110**. The hook portion **145** is extended from the coupling portion **141** installed in the door panel **110** and protrudes from the door panel **100** through the door panel **100**.

According to this exemplary embodiment, a latch hole **113** is formed in the door panel **110** that forms a passage for connecting the mounting space with the outside of the door panel **110**. The hook portion **145** may get into the door panel **110**, pass through the latch hole **113** and protrude from the door panel **110**.

The latch hole **113** is formed in the other end on the side of the door panel **110**. That is, the latch hole **113** forms a passage that passes through the door panel **110** in the lateral direction. The hook portion **145** penetrates through the side portion of the door panel **110** via the passage formed in the lateral direction and then extend toward the rear side of the door panel **110**.

That is, the hook portion **145** extends out of the door panel **110** through the side portion of the door panel **110**, and then protrudes toward the front face of the main body **10**.

The hook portion **145** protruding toward the front face of the main body **10** may be inserted into the main body **10** through the latch slot formed in the front face of the main body **10** when the door **100** shields the cooking chamber **15**. In this manner, the hook portion **145** inserted into the main body **10** may be engaged with the latch lever installed in the main body **10**, such that the latch mechanism **140** can be engaged with the latch lever.

The latch mechanism **140** is installed in the door **100** such that it comes in contact with the front plate **14** that forms the front face of the main body **10**. The latch hole **113** is formed at a position adjacent to the position where the latch mechanism **140** is located.

In addition, the structure for shielding electromagnetic waves to be described later is also formed in the door panel **110**, and the structure has to be located in a region facing the front surface of the main body **10** in order to form a circuit for shielding electromagnetic waves. Accordingly, the structure has to be disposed in the region in contact with the front plate **14** that forms the front face of the main body **10**, and thus the latch hole **113** has to be located in the structure or very closely to the structure.

A side wall portion **115** is formed on the inner side surface of the door panel **110**. The side wall portion **115** extends along the periphery of the door panel **110** and protrudes in the thickness direction of the door panel **110** to form a side wall surrounding a choke seal structure **150** to be described below.

The structure for shielding electromagnetic waves is installed at the door panel **110** to form the structure for preventing electromagnetic waves from leaking and may include the choke seal structure **150** extended along the periphery of the door **110**. The detailed description on the structure for shielding electromagnetic waves will be provided below.

The choke cover **160** is disposed between the front face **14** of the main body **10** and the door panel **110**. The choke cover **160** is typically formed of a molded product and is formed as a separate piece from the door panel **110** to be installed on the inner side surface of the door panel **110**. The choke cover **160** installed as described above shields the structure for shielding electromagnetic waves formed by the choke seal structure **150** and forms the rear exterior of the door **100**.

[Structure for Shielding Electromagnetic Waves]

FIG. **3** is a perspective view showing the configuration of the choke seal structure shown in FIG. **2**.

Referring to FIGS. **1** to **3**, the structure for shielding electromagnetic waves forms an LC resonant circuit for preventing leakage of electromagnetic waves through a gap between the front face **14** of the main body **10** and the door **100**, and may include the choke seal structure **150**.

The choke seal structure **150** may have a length extending along the periphery of the door panel **110** and may have a plurality of chokes **151** and **153** and slots **155** arranged in the longitudinal direction of the choke seal structure **150**.

Each of the chokes **151** and **153** is formed in such a shape that a bottom face a, an inner side face b and a top face c are connected in a "C" shape.

The bottom face a is extended in the width direction of the door panel **110** from the side wall portion **115** forming the side walls outside the choke seal structure **150**.

The inner side face b is extended from the bottom face a in the thickness direction of the door panel **110**, that is, in the direction that the side wall portion **115** protrudes. This inner side face b is connected to the bottom face a to form an "L" shape.

The top face c is extended from the inner side face b toward the side wall portion **115**. The top face c may be connected to the inner side face b to form a "⌈" shape. In this exemplary embodiment, the top face c protrudes from the inner side face b in the longitudinal direction of the choke seal structure **150**.

Each of the chokes **151** and **153** is provided such that the bottom face a, the inner side face b and the top face c are connected in a "C" shape, and a choke room is defined by them.

The choke seal structure **150** thus formed constitutes an LC resonant circuit composed of a combination of the inductance L and the capacitance C. For example, the inner side face b of each of the chokes **151** and **153** forms the inductance L component, and the top face c forms the capacitance C component.

The resonance frequency f0 determined by the inductance L and the capacitance C is represented as follows:

$$f0=1/2\pi\sqrt{LC}$$

When the frequency of an electromagnetic wave traveling toward the choke seal structure **150** is equal to the resonance frequency f0, the electromagnetic wave is filtered by the choke seal structure **150** and is blocked.

The LC resonant circuit formed by the choke seal structure **150** blocks leakage of the electromagnetic wave through the gap between the front face **14** of the main body **10** and the door **100** at the periphery of the door **100**.

In the choke seal structure **150**, a number of slots **155** are formed periodically. That is, a number of slots **155** are arranged at a predetermined interval in the longitudinal direction of the choke seal structure **150** so that the choke seal structure **150** is divided into a plurality of chokes **151** and **153**.

Electromagnetic waves incident into the cooking chamber **15** from the magnetron are resonated in a specific mode inside the cooking chamber **15**. These various modes determine the angle of incidence toward the door **100**. Since it is difficult to shield electromagnetic waves having various angles of incidence with a choke having a simple structure, the choke seal structure **150** is formed with the periodic slots **155** as described above. The slots **155** are designed to effectively shield incident electromagnetic waves with random angles of incidence.

The plurality of chokes **151** and **153** partitioned by the slots **155** may be divided into first chokes **151** and second chokes **153**.

In this embodiment, among the chokes **151** and **153** forming the choke seal structure **150**, the first chokes **151** are defined as chokes in each of which the latch hole **113** is

formed in the inner side face b. The second chokes **153** are defined as other chokes than the first chokes **151** among the chokes **151** and **153** forming the choke seal structure **150**, in each of which no latch hole **113** is formed in the inner side face b.

Typically, the choke seal structure **150** is designed based on the second chokes **153**. Specifically, the choke seal structure **150** is designed so that the arrangement of the chokes and the slots of the predetermined shapes satisfying the resonance frequency form a periodical repeated pattern.

However, when the latch hole **113** is formed in some of these chokes, the shape of the choke becomes uneven at the position where the latch hole **113** is formed, so that the periodic structure of the choke is broken.

For example, when the latch hole **113** is formed in the inner side face b of the first choke **151**, the length of the inner side face b near the first choke **151** become shorter, and thus the shape of the chokes become uneven (see FIG. **4**). Herein, the length of the inner side face refers to the length of the inner side face extending in the thickness direction of the door panel. In the portion where the shape becomes uneven, the inductance L component is reduced such that the frequency of the LC resonant circuit designed beforehand deviates from the resonance frequency f0. As a result, electromagnetic waves may leak in the portion that thus the performance of the choke is deteriorated.

In the light of the above according to the exemplary embodiment of the present disclosure, the structure of the first choke **151** having the latch hole **113** formed in the inner side face b is designed as described below.

Specifically, the first choke **151** is designed such that the capacitance C component is increased as much as the inductance L component is decreased in the inner side face b, such that the LC resonant circuit formed at the portion can satisfy the resonance frequency f0.

To this end, in the first choke **151**, a connecting face d for connecting between two top faces c adjacent to each other in the longitudinal direction of the choke seal structure **150** is formed.

According to this exemplary embodiment, the first choke **151** consists of two chokes having the latch hole **113** formed in the inner side face b.

According to this exemplary embodiment, the connecting face d connects between two top faces c of the two chokes of the first choke **151**, respectively, and is flush with the two top faces c.

The connecting face d thus formed increases the overall length of the top faces c formed on the top of the first choke **151** in the longitudinal direction of the choke seal structure **150** (hereinafter referred to as periodic direction). As a result, the length of the entire top face c formed on the top of the first choke **151** is longer than the length of the top face c of the second choke **153** in the periodic direction.

As a result, near the first choke **151**, the capacitance (C) component formed by the first choke **151** is increased in proportion to the increase in length of the top face c of the first choke **151**.

In other words, in order to keep the resonance frequency f0 in the first choke **151** equal to the resonance frequency f0 in the second choke **153**, the capacitance (C) component is increased as much as the inductance (L) is decreased.

In general, when the inductance (L) components decrease and the capacitance (C) components increase, the frequency band is widened and thus the electromagnetic wave filtering characteristic is improved. According to this embodiment, the problem of breaking the choke period structure due to the latch hole **113** can be solved by using this principle, and the electromagnetic wave shielding characteristic according to the frequency variations can be improved.

[Operation and Effect of Structure for Shielding Electromagnetic Waves]

FIG. **4** is a perspective view showing a configuration of a choke seal structure formed in a door of an existing cooking appliance. FIG. **5** is a graph showing an S-parameter measured at a door gap of an existing cooking appliance. FIG. **6** is a graph showing an S-parameter measured at a door gap of the cooking appliance according to a first exemplary embodiment of the present disclosure. It shows a result obtained from an experiment for measuring electromagnetic waves leaked from the door gap of the cooking appliance. In the above experiment, the experimental conditions are the same except for the configuration of the choke seal structure.

Hereinafter, the operation and effects of the structure for shielding electromagnetic waves according to the exemplary embodiment of the present disclosure will be described with reference to FIGS. **3** to **7**.

Referring to FIGS. **3** and **4**, a difference between the structure for shielding electromagnetic waves according to the exemplary embodiment of the present disclosure and the choke seal structure formed in the door of the existing cooking appliance lies in the connecting face d.

Specifically, in the choke seal structure formed in the door of the existing cooking appliance, the length of the inner side face b at the position where the latch hole **113** is formed (herein, the length of the inner side face refers to the length of the inner side face extending in the thickness direction of the door panel) is received and thus the shape of the choke becomes uneven. As a result, the inductance L component is reduced in the position, and the previously designed periodic structure of the LC resonant circuit is broken.

The choke seal structure provided in the cooking appliance using the high frequency supplied by the magnetron as the heat source should have a high shielding performance against electromagnetic waves having the frequency of 2.45 GHz which is the frequency of electromagnetic waves supplied by the magnetron.

However, it can be seen from the graph shown in FIG. **5** that in the choke seal structure formed in the door of the existing cooking appliance, there are the leakages of the electromagnetic waves around the frequency of 2.45 GHz.

In contrast, in the structure for shielding electromagnetic waves according to the exemplary embodiment of the present disclosure, the connecting face d is formed which increases the overall length of the top face c formed on the top of the first choke **151** in the periodic direction of the choke seal structure **150**. Accordingly, near the first choke **151**, the capacitance C component formed by the first choke **151** is increased in proportion to the increased length of the top face c of the first choke **151**. As a result, the resonance frequency f0 of the region can be kept the same as the other regions.

It can be seen from the graph shown in FIG. **6** that the structure for shielding electromagnetic waves according to the exemplary embodiment of the present disclosure exhibits excellent shielding performance against the electromagnetic waves around the frequency of 2.45 GHz.

FIG. **7** is a graph showing results obtained by comparing leaked power measured at a door gap of the existing cooking appliance with that of the cooking appliance according to the first exemplary embodiment of the present disclosure. It shows a result obtained from an experiment for measuring electromagnetic waves leaked from the door gaps of the cooking appliances.

In the above experiment, the experimental conditions are the same except for the configuration of the choke seal structure. In the graph, the positions are determined by measuring distances from the reference point in the portion where the choke seal structure is formed on the door. The latch holes are located in the range of 20 to 40 mm, and in the range of 130 to 150 mm.

Referring to FIG. **7**, in the choke seal structure A formed in the door of the existing cooking appliance, a large leaked power was measured in the range of 10 to 70 mm around the latch hole. In addition, some leaked power was measured in the range of 120 to 160 mm as well, though it was smaller than that in the range of the 10 to 70 mm.

These results are attributed to the fact that the shape of the chokes became uneven at the position where the latch hole is formed, so that the periodic structure of the choke is broken and thus the leakage of the electromagnetic wave occurred at the position.

In contrast, in the structure for shielding electromagnetic waves B according to the exemplary embodiment of the present disclosure, leaked power was rarely measured throughout the all positions including the latch hole and its vicinity. As a result, it can be seen that the structure B according to the exemplary embodiment of the present disclosure exhibits very excellent electromagnetic wave shielding performance even with the latch hole formed in the choke seal structure.

According to the structure for shielding electromagnetic waves according to the exemplary embodiment of the present disclosure, a door and a cooking appliance therewith, the top faces of the chokes having the latch hole formed are connected by the connecting face to thereby increase the overall length of the top face, such that the capacitance C components are increased as much as the inductance L components are decreased, thereby maintaining the resonance frequency f0. Therefore, it is possible to provide stable electromagnetic wave shielding performance even if the latch hole is formed in the choke seal structure.

According to the structure for shielding electromagnetic waves according to the exemplary embodiment of the present disclosure, a door and cooking appliance therewith, a large latch hole is allowed to be formed, so that the inductance L component of the choke can be reduced, and the overall length of the top face can be increased accordingly. Therefore, it is possible to provide a stable electromagnetic wave shielding performance while increasing the size of the latch hole to thereby reducing the degree of difficulty of the latch installation work and reducing the time required.

[Variations of Structure for Shielding Electromagnetic Waves]

The above-described structure for shielding electromagnetic waves is merely an exemplary embodiment of the present disclosure, and variations thereof can be contemplated.

FIG. **8** is a perspective view showing the configuration of a choke seal structure according to a second exemplary embodiment of the present disclosure. FIG. **9** is a perspective view showing the configuration of a choke seal structure according to a third exemplary embodiment of the present disclosure.

Hereinafter, other exemplary embodiments of the present disclosure will be described with reference to FIGS. **8** and **9**.

Like reference numerals to those used in the above drawings denote like elements, and redundant descriptions of such elements will not be repeated. It is to be noted that in the following description, "length" refers to "length in the periodic direction."

Referring to FIG. **8**, a choke seal structure **150***a* according to the second exemplary embodiment is different from the choke seal structure **150** shown in FIG. **3** in that the length of a top face c of a first choke **151***a* is reduced.

According to the second exemplary embodiment, the overall length of the top face c of the first choke **151***a*, which is extended by the connecting face d, is larger than the length of the top face c of each of the second chokes **153** and is equal to the length of the inner side face b connected thereto.

By determining the shape of the first choke **151***a* as described above, it is possible to avoid that the capacitance C components formed by the top face c and the connecting face d in the first choke **151***a* is increased too much. Thus, the choke seal structure can be designed more efficiently for maintaining the resonance frequency f0 around the first choke **151***a*.

Referring to FIG. **9**, a choke seal structure **150***b* according to the third exemplary embodiment of the present disclosure has the shape of the first choke **151***a* according to the second embodiment, and the periodic structure of the entire choke including the first choke **151***a* and the second choke **153***b* are rearranged.

In the choke seal structure **150***a* according to the second exemplary embodiment shown in FIG. **8**, as the length of the top face c of the first choke **151** is reduced, such that the distance between the first choke **151***a* (see FIG. **8**) and the second choke **153** is increased. In view of this, according to the third embodiment, the chokes are relocated so that the distance between the first choke **151***a* and the second choke **153** is kept constant. As a result, the choke can be designed more efficiently for providing stable electromagnetic wave shielding performance.

Although the exemplary embodiments of the present disclosure have been described with reference to the accompanying drawings, these are merely illustrative. It will be appreciated by those skilled in the art that various modifications and equivalents are possible without departing from the scope of the present disclosure. Accordingly, the true scope sought to be protected is defined solely by the claims.

What is claimed is:

1. A structure for shielding electromagnetic waves, comprising:

a choke seal structure having a bottom face extended from a side wall portion formed at a periphery of a door in a plane direction defined by the door, an inner side face extended from the bottom face in a thickness direction of the door, and a top face extended from the inner side face toward side wall portion, the choke seal structure having a length extending along the periphery of the door; and

a plurality of slots arranged in a longitudinal direction of the choke seal structure at a predetermined spacing other than where a connecting face is disposed in place of the slot, and partitioning the choke seal structure into a plurality of chokes,

wherein each of the choke has the inner side face and the top face,

wherein the chokes are divided into a first choke having a latch hole formed in the inner side face and a second choke having no latch hole formed therein,

in the first choke, the connecting face is disposed between the top faces in place of the slot between the top faces, and

a total length of the top faces and the connecting face of the first choke is longer than a length of the top face of the second choke.

2. The structure of claim **1**, wherein the connecting face is flush with the top faces and connects therebetween.

3. The structure of claim **1**, wherein the top face protrudes more than the inner side face in the longitudinal direction of the choke seal structure in a slot.

4. The structure of claim **1**, wherein a length of the top faces connected by the connecting face is equal to the length of the inner side face in the longitudinal direction of the choke seal structure.

5. The structure of claim **1**, wherein the top face protrudes more than the inner side face in the longitudinal direction of the choke seal structure in a slot.

6. The structure of claim **1**, wherein a length of the top face of the first choke is equal to the length of the inner side face in the longitudinal direction of the choke seal structure.

7. The structure of claim **6**, wherein a distance between the first choke and the second choke, and a distance between the second choke and another adjacent second choke, are equal.

8. A door comprising:

a door panel forming a frame of the door; and

a structure disposed at the door panel for shielding electromagnetic waves, wherein the structure for shielding electromagnetic waves comprises:

a choke seal structure having a bottom face extended from a side wall portion formed at a periphery of a door in a plane direction defined by the door, an inner side face extended from the bottom face in a thickness direction of the door, and a top face extended from the inner side face toward side wall portion, the choke seal structure having a length extending along the periphery of the door; and

a plurality of slots arranged in a longitudinal direction of the choke seal structure and partitioning the choke seal structure into a plurality of chokes,

wherein each of the choke has the inner side face and the top face,

wherein the chokes are divided into a first choke having a latch hole formed in the inner side face and a second choke having no latch hole formed therein, and

wherein a length of the top face of the first choke is longer than a length of the top face of the second choke.

9. The door of claim **8**, wherein the top face of the first choke comprises: a connecting face connecting between top faces of some of the plurality of chokes.

10. The structure of claim **8**, wherein the top face protrudes more than the inner side face in the longitudinal direction of the choke seal structure in a slot.

11. The structure of claim **8**, wherein a length of the top face of the first choke is equal to the length of the inner side face in the longitudinal direction of the choke seal structure.

12. The structure of claim **11**, wherein a distance between the first choke and the second choke, and a distance between the second choke and another adjacent second choke, are equal.

13. A cooking appliance comprising:

a main body having a cooking chamber therein and an open front face;

a door pivotally connected to the front face of the main body to open or close the cooking chamber; and

a latch mechanism installed at the door to fasten or release the door to/from the main body, wherein the door comprises

a door panel forming a frame of the door;

a structure disposed at the door panel for shielding electromagnetic waves; and

a latch hole formed by penetrating the structure for shielding electromagnetic waves, wherein at least a part of the latch mechanism installed in the door passes therethrough, wherein the structure for shielding electromagnetic waves comprises:

a choke seal structure having a bottom face extended from a side wall portion formed at a periphery of a door in a plane direction defined by the door, an inner side face extended from the bottom face in a thickness direction of the door, and a top face extended from the inner side face toward side wall portion, the choke seal structure having a length extending along the periphery of the door; and

a plurality of slots arranged in a longitudinal direction of the choke seal structure at a predetermined spacing other than where a connecting face is disposed in place of the slot, and partitioning the choke seal structure into a plurality of chokes,

wherein each of the choke has the inner side face and the top face,

wherein the chokes are divided into a first choke having a latch hole formed in the inner side face and a second choke having no latch hole formed therein,

in the first choke, the connecting face is disposed between the top faces in place of the slot between the top faces, and

a total length of the top faces and the connecting face of the first choke is longer than a length of the top face of the second choke.

14. The cooking appliance of claim **13**, wherein the inner side surface forms an inductance component, the top face forms a capacitance component, and the connecting face increases the capacitance component formed by the top face.

15. The structure of claim **13**, wherein the top face protrudes more than the inner side face in the longitudinal direction of the choke seal structure in a slot.

16. The structure of claim **13**, wherein a length of the top faces connected by the connecting face is equal to the length of the inner side face in the longitudinal direction of the choke seal structure.

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